APPENDIX G

GAMMA RADIATION SURVEY PROCEDURES

PORTABLE SURVEY INSTRUMENT

OPERABILITY CHECKS

PROCEDURE NO: 376 REVISION NO: 6

PORTABLE SURVEY INSTRUMENT OPERABILITY CHECKS

1. SCOPE

1.1 Purpose

To provide a means to document the operability of portable survey instruments.

1.2 Applicability

This procedure is required of all project personnel performing radiological surveys using portable instruments.

2. REFERENCES

ANSI N323-1978

3. DEFINITIONS

Source Check:

A test of an instrument's response to a known radiation field in order to verify operability of the instrument.

4. REQUIREMENTS

4.1 Prerequisites

None.

4.2 Tools, Material, Equipment

4.2.1 Calibrated survey meters.

4.2.2 Necessary radioactive sources to verify operability of each type of instrument.

4.3 Precautions, Limits

Do not subject portable survey meters to physical abuse or water.

4.4 Acceptance Criteria

4.4.1 The survey instruments indicate a satisfactory response to the battery check prior to each day of use.

4.4.2 The survey instruments indicate a satisfactory response to the check source (mean ± 20%) prior to each day of use.

5. PROCEDURE

5.1 Portable survey instruments will be source checked, after repair and calibration, or prior to each day of use.

5.2 Alpha Instruments:

5.2.1 Select the desired instruments.

5.2.2 Record the current date and time on Attachment 1.

5.2.3 Check the calibration due date on each instrument to ensure that the calibration has not expired. If calibration has expired, go to paragraph 5.4 below.

5.2.4 Check instrument for satisfactory physical condition. If excessive dents, torn Mylar or loose parts are found, place the instrument out of service.

5.2.5 Perform a battery check and record the results on Attachment 1.

5.2.5.1 Replace the batteries if they are low.

5.2.5.2 If the batteries are dead, take the instrument "out of service".

5.2.6 Perform a source check and record the results in the appropriate columns on Attachment 1.

> NOTE
> The instrument must indicate within ± 20% of the expected response (source activity) listed on Attachment 1.

NOTE
The 43-20 alpha gas probes are interchangeable with the LM-12 count ratemeters. Periodic field checks of the instrument using the source attached to the instrument are required to verify continuing operability. Should the field check indicate no response or a reduced response, return the instrument to determine if the probe requires replacement or the if instrument requires repair.

5.2.7 Source check each quadrant of the Ludlum Model 43-20 alpha probe and record the results in the appropriate column.

5.2.8 Average the four quadrant reading and record this value on Attachment 1.

5.2.9 Record your initials next to each instrument checked on Attachment 1.

5.2.10 If an instrument is found to be inoperable, note on Attachment 1 why it is being placed out of service (i.e. out of calibration, damage repair, etc.) and go to 5.4 below.

5.3 Beta Gamma Instruments:

5.3.1 Select the desired instruments.

5.3.2 Record the current date and time on Attachment 1.

5.3.3 Check the calibration due date on each instrument to ensure that the calibration has not expired. If calibration has expired, go to paragraph 5.4 below.

5.3.4 Check instrument for satisfactory physical condition. If excessive dents, broken windows, or loose parts are found, place the instrument out of service.

5.3.5 Perform a battery check, and record the results on Attachment 1.

5.3.5.1 Replace the batteries if they are low.

5.3.5.2 If the batteries are dead, take the instrument "out of service".

5.3.6 Perform a source check with a Cs-137 source and record the results on Attachment 1.

NOTE
Reference readings shall be obtained on each instrument when exposed to a check source in a constant and reproducible manner at the time of, or promptly after, instrument calibration.

NOTE
The 44-40 and 44-38 (or equivalent) detector probes are interchangeable with beta-gamma instruments Ludlum model 3's. The detector probes can be interchanged as long as the detector is used with the same detector cable length that was used to calibrate the instrument.

5.3.7 Record your initials next to each instrument checked on Attachment 1.

5.3.8 If an instrument is found to be inoperable, note on Attachment 1 why it is being placed out of service (i.e. out of calibration, damage repair, etc.) and go to 5.4 below.

5.4 Instrument Out Of Calibration

5.4.1 When an instrument is found to be "out of calibration" or fails an operability check, immediately notify the Field Supervisor.

5.4.2 Source check failures ("out of calibration") are to be recorded in the instrument log book

5.4.3 The Field Supervisor shall determine the last date that the used instrument passed a source check, or the last calibration date, whichever is most recent.

5.4.4 Based on the last acceptable source check or calibration date, the Field Supervisor shall identify which radiological surveys were performed since then with the defective instrument.

5.4.5 The Field Supervisor shall determine whether regulatory or general information surveys were performed with the defective instrument.

5.4.6 Using previous surveys or previous knowledge of the survey data, the Field Supervisor shall determine whether the surveys taken with the defective instrument are acceptable "as is" or whether the surveys must be reperformed. In the case of regulatory surveys, they shall be retaken, if possible. If resurveying is not possible, the Field Supervisor will make a written assessment as to the quality of the data.

6. RECORDS/REPORTS/NOTIFICATIONS

6.1 Notifications required by the procedure will typically be verbal to the Field Supervisor.

6.2 Forward the completed Attachment 1 forms to Field Supervisor for review.

6.3 Any instruments that have dead batteries or failed the source checks have been removed from service and so noted on Attachment 1 and instrument log book.

7. ATTACHMENTS

7.1 Attachment 1 Portable Instrument Accountability Form (Example)

ATTACHMENT 1

DAILY PORTABLE INSTRUMENT CHECK

DATE	TIME	A.M. / P.M.

ALPHA SURVEY INSTRUMENTS

STANDARD S/N

INSTRUMENT TYPE AND SERIAL NO.	SOURCE ACTIVITY	INSTRUMENT RESPONSE	SOURCE ACTIVITY	INSTRUMENT RESPONSE	BATTERY CHECK	REMARKS				INITIALS
PRM-6 w/AC-3 PROBE 647										
653										
736										
765										
779										
1259										
Ludlum 43-20 Alpha Detector w/LM-12 Instrument		Average Response		Average Response		Indicate quadrant and response				
Inst. Number						1	2	3	4	

ATTACHMENT 1

DAILY PORTABLE INSTRUMENT CHECK

DATE	TIME	A.M P.M.

ALPHA SURVEY INSTRUMENTS

STANDARD S/N

INSTRUMENT TYPE AND SERIAL NO.	SOURCE ACTIVITY	INSTRUMENT RESPONSE	SOURCE ACTIVITY	INSTRUMENT RESPONSE	BATTERY CHECK	REMARKS				INITIALS
Ludlum 43-20 Alpha Detector w/LM-12 Instrument		Average Response		Average Response		Indicate quadrant and response				
Inst. Number						1	2	3	4	

DAILY PORTABLE INSTRUMENT CHECK

DATE	TIME	A.M. / P.M.

BETA-GAMMA INSTRUMENTS

STANDARD S/N

INSTRUMENT TYPE AND SERIAL NO.	PROBE USED	BATTERY CHECK	HIGH VOLTAGE CHECK	RESPONSE CHECK	REMARKS	INITIALS
PRM-6 648	HP-210					
1263	HP-210					
1270	HP-210					
E-530 410	HP-270					
1133	HP-270					
1180	HP-270					
PRM-7 364	NaI					
699	NaI					
704	NaI					
707	NaI					
H.P.I. 1010 345	IC					

ATTACHMENT 1

DAILY PORTABLE INSTRUMENT CHECK

DATE	A.M. / P.M.

BETA-GAMMA INSTRUMENTS

STANDARD S/N

INSTRUMENT TYPE AND SERIAL NO.	PROBE USED	BATTERY CHECK	HIGH VOLTAGE CHECK	RESPONSE CHECK	REMARKS	INITIALS
LUDLUM MODEL 3 113990	44-40					
115345	44-40					
115385	44-40					
115025	44-40					
LUDLUM MODEL 3 114947	44-38					
115046	44-38					
115065	44-38					
115117	44-38					
115375	44-38					

CALIBRATION CHECK OF
VENDOR-CALIBRATED PORTABLE SURVEY METERS

PROCEDURE NO: 378 REVISION NO: 2

CALIBRATION CHECK OF VENDOR-CALIBRATED PORTABLE SURVEY METERS

1. SCOPE

1.1 Purpose

To provide a standard procedure for checking vendor calibration of portable survey instruments.

1.2 Applicability

This procedure applies to all portable survey instruments that are calibrated by an offsite vendor.

2. REFERENCES

Tech Manual for the applicable portable meter.

3. DEFINITIONS

PORTABLE SURVEY METER

A portable, battery operated, general purpose survey instrument used for the detection and measurement of radiation.

4. REQUIREMENTS

4.1 Prerequisites

The instrument has been sent offsite for calibration.

4.2 Tools, Material, Equipment

4.2.1 Radioactive sources, of a sufficient and known activity to check calibration of the instrument.

4.3 Precautions, Limits

4.3.1 Use care when disassembling and reassembling the source container that no parts are lost.

4.3.2 Use care when using an electroplated source that the source face is not damaged by contact with the probe.

4.4 Acceptance Criteria

The instrument response to certified sources is within +/- 20%. Calibration certification shall be NIST traceable.

5. PROCEDURE

5.1 Visually inspect the meter for damage.

5.2 Review the calibration certificate to ensure AS LEFT meter responses are within the acceptance criteria.

5.3 Check the meter to ensure that the calibration label dates correspond to the calibration certificate dates.

5.4 Perform a battery check.

5.4.1 If unsatisfactory, replace the batteries.

5.5 Complete the top portion of applicable Attachment with instrument I.D.

5.6 DELETE

5.7 For beta-gamma dose rate instruments:

5.7.1 Remove the screws from the bottom of the Dosimeter Corporation of America Desktop Calibrator, Model 3060, and extract the bottom plate with the center post containing the source.

5.7.2 Set the instrument on the X1 scale.

5.7.3 Place the center of the probe case alongside the top of the center post.

5.7.4 Observe the meter reading and record on Attachment 1. Verify that the reading is within the acceptable range listed on Attachment 1.

5.8 For beta-gamma count rate instruments:

5.8.1 Conduct a response check with a beta-emitting source.

5.8.1.1 Record the source type, serial number, source activity, and date on Attachment 2.

5.8.1.2 Detector efficiency shall be checked 20% of manufacturers specification, ***if recorded on the calibration certificate. If not recorded, mark N/A on Attachment 2.***

5.8.1.3 Record the observed count rate on Attachment 2.

5.8.1.3 Identity test/check status by checking appropriate pass/fail block on the attachments record.

5.9 For alpha instruments:

5.9.1 Conduct a source check with a four-decade alpha source set.

5.9.1.1 Calculate the acceptable ranges for each decade as $\pm$ 40% - 60% of the source activity. Record on Attachment 3.

5.9.1.2 When performing this check on the Ludlum Model 43-20 large-area probes, it is necessary to check each quadrant of the probe with at least one of the sources.

5.9.1.3 Record the results on Attachment 3. If the source check is performed on any other instrument than a Ludlum Model 43-20, the extra spaces in each decade shall be marked "N/A".

5.9.2 Verify that the activity is within the range indicated on Attachment 3.

5.10 If the instrument meets the acceptance criteria as listed on the applicable Attachment, the instrument may be placed into service.

5.11 Update the equipment history log. Attach the vendor's calibration certificate to applicable Attachment.

5.12 Forward the appropriate Attachment to the Field Supervisor for review.

5.13 If the instrument calibration or the source check is unsatisfactory, the instrument shall be returned to the vendor for repair/recalibration.

6. RECORDS/REPORTS/NOTIFICATIONS

6.1 The appropriate Attachment, which has been reviewed and signed by the Field Supervisor, shall be maintained as a record.

6.2 All associated vendor certificates shall be maintained as a record.

7. ATTACHMENTS

7.1 Attachment 1 - Instrument Calibration Verification Form for Beta-Gamma Dose Rate Instruments.

7.2 Attachment 2 - Instrument Calibration Verification Form for Beta-Gamma Count Rate Instruments.

7.3 Attachment 3 - Instrument Calibration Verification Form for Alpha Instruments.

ATTACHMENT 1

INSTRUMENT CALIBRATION VERIFICATION FORM

FOR BETA-GAMMA DOSE RATE INSTRUMENTS

INSTRUMENT TYPE _____ *S/N*

MANUFACTURER _____ *PROBE TYPE*

CALIBRATION METHOD OFFSITE CALIBRATION - ON-SITE RESPONSE CHECK

RESPONSE CHECK SOURCE TYPE & SERIAL NO. ***DCA DESKTOP CALIBRATOR, MODEL 3060***

INSTRUMENT RESPONSE _____ mR/h

ACCEPTABLE RANGE ***4.7 - 7.0*** ***mR/h***

VENDOR CALIBRATION CERTIFICATE ATTACHED YES ____ *NO* ____

not attached, please explain why: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

PASS _____ *FAIL* _____

CAL DATE _____ *CAL DUE DATE* _____

PREPARED BY: _____ *REVIEWED BY:* _____

HP TECHNICIAN /Date *FIELD SUPERVISOR /Date*

ATTACHMENT 2

INSTRUMENT CALIBRATION VERIFICATION FORM

FOR BETA-GAMMA COUNT RATE INSTRUMENTS

Acceptance Criteria: 20% of Manufacturer's Specifications

INSTRUMENT TYPE _____ ***S/N*** _____

MANUFACTURER _____ ***PROBE TYPE*** _____

CALIBRATION METHOD OFFSITE CALIBRATION - ON-SITE RESPONSE CHECK

RESPONSE CHECK SOURCE TYPE & SERIAL NO.

SOURCE ACTIVITY _____ ***DPM***

INSTRUMENT RESPONSE _____ ***CPM***

DETECTOR EFFICIENCY _____

MANUFACURE'S SPECIFIED EFFICIENCY _____

DETECTOR EFF/MANUFACTURER EFF # 20% _____

VENDOR CALIBRATION CERTIFICATE ATTACHED YES _____ ***NO*** _____

PASS _____ ***FAIL*** _____

CAL DATE _____ ***CAL DUE DATE*** _____

PREPARED BY: _____ ***REVIEWED BY:*** _____

HP TECHNICIAN /Date ***FIELD SUPERVISOR /Date***

ATTACHMENT 3

INSTRUMENT CALIBRATION VERIFICATION FORM

FOR ALPHA INSTRUMENTS

ACCEPTANCE CRITERIA: BETWEEN 40% AND 60% OF SOURCE ACTIVITY

INSTRUMENT TYPE _____ *S/N* _____

MANUFACTURER _____ *PROBE TYPE* _____

CALIBRATION METHOD *OFFSITE CALIBRATION - ON-SITE RESPONSE CHECK*

RESPONSE CHECK SOURCE TYPE & SERIAL NO. _____

INSTRUMENT RESPONSE 1ST DECADE _____ / _____ / _____ / _____ *CPM*

ACCEPTABLE RANGE _____ *CPM*

INSTRUMENT RESPONSE 2ND DECADE _____ / _____ / _____ / _____ *CPM*

ACCEPTABLE RANGE _____ *CPM*

INSTRUMENT RESPONSE 3RD DECADE _____ / _____ / _____ / _____ *CPM*

ACCEPTABLE RANGE _____ *CPM*

INSTRUMENT RESPONSE 4TH DECADE _____ / _____ / _____ / _____ *CPM*

ACCEPTABLE RANGE _____ *CPM*

VENDOR CALIBRATION CERTIFICATE ATTACHED YES _____ *NO* _____

PASS _____ *FAIL* _____

IF NOT ATTACHED, PLEASE EXPLAIN WHY: _____

_____

_____

CAL DATE _____ *CAL DUE DATE* _____

PREPARED BY: _____ *REVIEWED BY:* _____

HP TECHNICIAN /Date *FIELD SUPERVISOR /Date*

CALIBRATION OF THE LUDLUM SCALER RATEMETER

MODEL 2221

PROCEDURE NO: 379 REVISION NO: 2

CALIBRATION OF THE LUDLUM SCALER RATEMETER MODEL 2221

1. SCOPE

1.1 Purpose

To provide a standard procedure for the calibration of the Ludlum Ratemeter, model 2221 with the 44-10, 44-62 sodium iodide scintillation probes.

The 2221 is a portable, battery operated, self contained counting instrument designed for operation with scintillation, proportional or G-M detectors. When combined with scintillation detectors, the 2221 is used for the detection and measurement of gamma radiation. This instrument is used for down hole gamma logging as well as the detection of surface radioactivity.

1.2 Applicability

This instrument will be calibrated every twelve months, after repairs, or when the instrument readings are questionable. This procedure can be used with any ratemeter/sodium iodide scintillation detector combination. Typically the 44-62 half-inch detector is not used for surface scanning.

2. REFERENCES

2.1 Technical Manual for Scaler Ratemeter, Model 2221

2.2 Kerr-McGee calibration standard blocks

3. DEFINITIONS

N/A

4. REQUIREMENTS

4.1 Prerequisites

None.

4.2 Tools, Material, Equipment

4.2.1 Small screwdriver.

4.2.2 Ludlum Model 500 pulser or equivalent.

4.2.3 Certified, NIST-traceable source of sufficient activity to allow a response check.

4.3 Precautions, Limit

4.3.1 The connector cord is easily damaged if the weight of the 44-10 detector is suspended with it.

4.3.2 Do not leave the reading lamp on for any length of time as it will rapidly drain the battery voltage.

4.4 Acceptance Criteria

The instrument response to the certified calibration source should be within ± 20%.

5. PROCEDURE

5.1 Generic calibration applicable to all detectors.

NOTE: Calibrations for Surface activity and downhole logging are detailed in section 5.2.

5.1.1 Check the battery condition by pressing the "BAT" button with instrument switched on. If the meter does not indicate the battery charge above 5.3 volts, replace the four (4) D-cell batteries.

5.1.2 Set the threshold value as follows:

5.1.2.1 With the instrument turned on, press the threshold button. Read the displayed reading. If necessary adjust the "**THR**" adjustment screw until the threshold reads **100.**

NOTE: The 'THR" adjustment screw is located under the calibration cover.

5.1.3 Set the window value as follows:

5.1.3.1 With the instrument turned on press the **"WIN"** button and observe the reading, if the reading does not indicate approximately **3830** then with the "win button depressed adjust the reading to 3830.

NOTE: The **"WIN"** adjustment screw is located under the calibration cover

5.2 SPECIFIC USE CALIBRATION

5.2.1 Surface Soil concentration Calibration

5.2.1.1 Use attachment 1 for calibration if the instrument is to be used for surface surveying.

5.2.2 Downhole logging

5.2.2.1 If instrument is to be used for downhole logging then proceed to attachment 2 for the calibration procedure.

6. RECORDS/REPORTS/NOTIFICATIONS

6.1 Instrument is properly calibrated and available for use or it has been placed out of service for repair.

6.2 Attachments have been reviewed and filed.

6.3 The equipment history has been updated.

7. ATTACHMENTS

7.1	Attachment 1	Soil Concentration Calibration Instructions
7.2	Attachment 2	Downhole Logging Calibration Instructions
7.3	Attachment 3	Soil Concentration Calibration Form
7.4	Attachment 4	Calibration Sticker
7.5	Attachment 5	Downhole logging Calibration Data Form

Attachment 1
CALIBRATION OF 2221 WITH 44-10 FOR SURFACE SCANNING

WORK INSTRUCTION

1. Record the instrument and detector serial numbers on attachment 3.
2. Perform a scaler linear check as follows:
   - 2.1 Record the pulser model/serial number on attachment 3
   - 2.2 Record the calibration due date on attachment 3
   - 2.3 Check the threshold setting to insure that it is set at 100mv, if it is not set at 100mv then adjust it in accordance with section 5. .
   - 2.4 Connect the pulser to the instrument.
   - 2.5 Send 400,4000.40K and 400K cpm pulses into the meter
   - 2.6 Record the meter responses in the "AS FOUND" column of attachment 3.
   - 2.7 If the meter does not indicate the correct response to within ± 10% perform the following steps as necessary:
     - 2.7.1 Send 400 cpm pulses into the meter and adjust the reading for an acceptable reading
     - 2.7.2 Send 4000 cpm pulses into the meter and adjust the reading for an acceptable reading
     - 2.7.3 Send 40k cpm pulses into the meter and adjust the reading for an acceptable reading
     - 2.7.4 Send 400k cpm pulses into the meter and adjust the reading for an acceptable reading
     - 2.7.5 Record the resulting readings in the after adjustment column on attachment 3
     - 2.7.6 If unable to adjust to within ± 10% , place the instrument out of service for repair.

1.3 PERFORM A VOLTAGE AND BACKGROUND AS FOLLOWS:

- 1.3.1 Record the source isotope and serial number on attachment 3.
- 1.3.2 Perform a source plateau by exposing the detector to a radioactive source and recording the meter reading at 50 volt increases until a plateau is developed. record the voltage and the meter reading for each increment on attachment 3.
- 1.3.3 At selected voltage increments perform a background reading and record the meter reading on attachment 3 .
  - 1.3.3.1 Set the meter high voltage to between 1/3 and 1/2 of the voltage plateau.
  - 1.3.3.2 Record the selected high voltage setting on attachment 3.

1.4 INSTRUMENT BACKGROUND

- 1.4.1 Perform an instrument ***background*** as follows:
  - 1.4.1.1 Using the four background blocks, perform six - one minute counts (with the instrument set at the selected voltage) and set in the scaler mode.
  - 1.4.1.2 Record these readings on attachment 3
  - 1.4.1.3 Average the six readings and record the result on attachment 3.

1.5 CALIBRATION SOURCE BLOCK DATA

- 1.5.1 Record the source block serial number on attachment 3
- 1.5.2 Perform six one minute source block counts
- 1.5.3 Record the results on attachment 3
- 1.5.4 Average the source block cpm and record the result on attachment 3
- 1.5.5 Subtract the average background (recorded on attachment 3) from the average source block cpm .
- 1.5.6 Record this number as the net average on attachment 3.

1.6 ACTIVITY CALCULATION

1.6.1 Perform the calculation on attachment 3 to determine the activity cutoff value for 7.2 pCi/g.

1.6.2 Sign attachment 3

1.7 CALIBRATION STICKER

1.7.1 Complete the information required on attachment 4 and attach it to the side of the instrument.

Attachment 2

CALIBRATION OF 2221 FOR GAMMA DOWNHOLE LOGGING

WORK INSTRUCTION

1.1 RECORD THE INSTRUMENT AND DETECTOR SERIAL NUMBERS ON ATTACHMENT 3.

1.2 PERFORM A SCALER LINEAR CHECK AS FOLLOWS:

- 1.2.1 Record the pulser model/serial number on attachment 3
- 1.2.2 Record the calibration due date on attachment 3
- 1.2.3 Check the threshold setting to insure that it is set at 100mv, if it is not set at 100mv then adjust it in accordance with section 5. .
- 1.2.4 Connect the pulser to the instrument.
- 1.2.5 Send 400,4000.40K and 400K cpm pulses into the meter
- 1.2.6 Record the meter responses in the "AS FOUND" column of attachment 4.
- 1.2.7 If the meter does not indicate the correct response to within ± 10% perform the following steps as necessary:
  - 1.2.7.1 Send 400 cpm pulses into the meter and adjust the reading for an acceptable reading
  - 1.2.7.2 Send 4000 cpm pulses into the meter and adjust the reading for an acceptable reading
  - 1.2.7.3 Send 40k cpm pulses into the meter and adjust the reading for an acceptable reading
  - 1.2.7.4 Send 400k cpm pulses into the meter and adjust the reading for an acceptable reading
  - 1.2.7.5 Record the resulting readings in the after adjustment column on attachment 3
  - 1.2.7.6 If unable to adjust to within ± 10%, place the instrument out of service for repair.

1.3 PERFORM A VOLTAGE AND BACKGROUND AS FOLLOWS:

- 1.3.1 Record the source isotope and serial number on attachment 3.
- 1.3.2 Perform a source plateau by exposing the detector to a radioactive source and recording the meter reading at 50 volt increases until a plateau is developed. record the voltage and the meter reading for each increment on attachment 4.
- 1.3.3 At selected voltage increments perform a background reading and record the meter reading on attachment 3 .
  - 1.3.3.1 Set the meter high voltage to between 1/3 and 1/2 of the voltage plateau.
  - 1.3.3.2 Record the selected high voltage setting on attachment 3.

1.4 INSTRUMENT BACKGROUND

- 1.4.1 Perform an instrument ***background*** as follows:
  - 1.4.1.1 Using the four background blocks, perform six-one minute counts (with the instrument set at the selected voltage) and set in the scaler mode.
  - 1.4.1.2 Record these readings on attachment 3
  - 1.4.1.3 Average the six readings and record the result on attachment 3.

1.5 CALIBRATION SOURCE BLOCK DATA

1.5.1 Record the source block serial number on attachment 3
1.5.2 Perform six one minute source block counts
1.5.3 Record the results on attachment 3
1.5.4 Average the source block cpm and record the result on attachment 3
1.5.5 Subtract the average background (recorded on attachment 3) from the average source block cpm.
1.5.6 Record this number as the net average on attachment 3.

1.6 ACTIVITY CALCULATION

1.6.1 Perform the calculation on attachment 3 to determine the activity cutoff value for 7.2 pCi/g.
1.6.2 Sign attachment 3

1.7 CALIBRATION STICKER

1.7.1 Complete the information required on attachment 4 and attach it to the side of the instrument.

1.8 DRUM CALIBRATION PROCEDURE

1.8.1 If the instrument and detector is also going to be used as a downhole Gamma logger the following calibration must also be performed.
1.8.2 After the instrument and detector have been calibrated for surface scanning, perform the following.
1.8.2.1 Connect the detector and the instrument with a 15 foot connecting cable.

1.8.2.2 Record the standard picocuries per gram for each calibration drum and record them on attachment *5*
1.8.2.3 Calibration Geometry must be the same as the Field Geometry, i.e. obtain a sample of the geoprobe steel pipe and insert it into the PVC calibration drums and place the down hole probe inside the geoprobe pipe.
1.8.2.4 Take three one minute readings in each of the calibration drums located at the REF, and record the reading in the appropriate column on attachment 5
1.8.2.5 Average the each three one minutes and record the result on attachment 5

1.9 ACTIVITY CALCULATION FOR WELL LOGGING

1.9.1 Perform a linear regression for the average readings for both the calibration drums equipped with steel augers as well as the PVC piping
1.9.2 Record the result on attachment 5
1.9.3 Calculate the activity for 5 pCi/g and & 7.2 pCi/g and record the results on attachment 5
1.9.4 Sign Attachment 5 and forward it for approval

1.10 CALIBRATION STICKER

1.10.1 Complete the information required on attachment 4 and attach it to the side of the instrument.

Ludlum Model 2221/44-10 Calibration

Model 2221 serial number: _____

Probe 44-10 serial number: _____

Date: _____

Scaler Linear Check

Pulser model/serial number: _____ / _____

Calibration Due Date: _____

Threshold set to 100 mv. _____ (tech. init.)

Pulser setting in cts.	Multipler	As Found Scaler reading in cts.	After Adjustment Scaler reading in cts.
_____	X1	_____	_____
_____	X10	_____	_____
_____	X100	_____	_____
_____	X1000	_____	_____

Voltage Plateau

Source isotope/serial number: _____ / _____

BKGD PLATEAU		SOURCE PLATEAU	
volts	counts	volts	counts
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Operating voltage selected: _____

Ludlum Model 2221/44-10 Calibration

Model 2221 serial number: _____

Probe 44-10 serial number: _____

Date: _____ window verified at about 3830

Instrument BKGD

1 minute BKDG counts

_____ _____

_____ _____

_____ _____

Average: _____

Source Block Data

Source block ID: _____

1 minute Source Block counts

_____ _____

_____ _____

_____ _____

Average: _____ cpm Net Average: _____ cpm

Activity Calculation

Net Average source count rate of: _____ cpm divided by 10 = _____

Times 7.2 = _____ (A)

Square root of (A) = _____ times 2 = _____ (B)

(A) plus the average BKGD = _____ CPM/7.2 pCi

The cutoff value is: _____ (CPM/7.2 pCi minus (B))

Calibration performed by: _____ DATE: _____

Calibration approved by: _____ DATE: _____

ATTACHMENT 4
CALIBRATION STICKER

ALER #	________	PROBE #	________	**Check** **Applicable Line**	
CAL DATE	________	TECHNICIAN	________	Geoprobe Pipe	____
				PVC Drum	____
CAL DUE	________	VOLTAGE SETTING	________	Auger Drum	____
				Cable Length	____
7.2 pCi/g = ________ CPM		SOIL CONCENTRATION	________	DOWNHOLE LOGGING	____

SCALER #	________	PROBE #	________	**Check** **Applicable Line**	
CAL DATE	________	TECHNICIAN	________	Geoprobe Pipe	____
				PVC Drum	____
CAL DUE	________	VOLTAGE SETTING	________	Auger Drum	____
				Cable Length	____
7.2 pCi/g = ________ CPM		SOIL CONCENTRATION	________	DOWNHOLE LOGGING	____

SCALER #	________	PROBE #	________	**Check** **Applicable Line**	
CAL DATE	________	TECHNICIAN	________	Geoprobe Pipe	____
				PVC Drum	____
CAL DUE	________	VOLTAGE SETTING	________	Auger Drum	____
				Cable Length	____
7.2 pCi/g = ________ CPM		SOIL CONCENTRATION	________	DOWNHOLE LOGGING	____

SCALER #	________	PROBE #	________	**Check** **Applicable Line**	
CAL DATE	________	TECHNICIAN	________	Geoprobe Pipe	____
				PVC Drum	____
CAL DUE	________	VOLTAGE SETTING	________	Auger Drum	____
				Cable Length	____
7.2 pCi/g = ________ CPM		SOIL CONCENTRATION	________	DOWNHOLE LOGGING	____

SCALER #	________	PROBE #	________	**Check** **Applicable Line**	
CAL DATE	________	TECHNICIAN	________	Geoprobe Pipe	____
				PVC Drum	____
CAL DUE	________	VOLTAGE SETTING	________	Auger Drum	____
				Cable Length	____
7.2 pCi/g = ________ CPM		SOIL CONCENTRATION	________	DOWNHOLE LOGGING	____

SCALER #	________	PROBE #	________	**Check** **Applicable Line**	
CAL DATE	________	TECHNICIAN	________	Geoprobe Pipe	____
				PVC Drum	____
L DUE	________	VOLTAGE SETTING	________	Auger Drum	____
				Cable Length	____
7.2 pCi/g = ________ CPM		SOIL CONCENTRATION	________	DOWNHOLE LOGGING	____

ATTACHMENT 5
DETECTOR CALCULATION

DETECTOR TYPE _____ SER #_____

CALIBRATION DRUMS W/PVC PIPING: CABLE LENGTH _____ DIAMETER OF PIPE _____ SCH. OF PIPE _____ 40, _____ 80

DRUM NUMBER	pCi/g	1ST COUNT (cpm)	2ND COUNT(cpm)	3RD COUNT(cpm)	AVERAGE COUNT
CD-1	1.7				
CD-8	12.9				
CD-7	23.4				

LINEAR REGRESSION FORMULA Y= A + BX WHERE Y= CPM AND X= pCi/g
A= R= 5.0 PCi/g =_____CPM
B= 7.2 PCi/g =_____CPM

CALIBRATION W/STEEL HOLLOW STEM AUGER PIPING: CABLE LENGTH _____ DIAMETER OF PIPE _____ SCH. OF PIPE _____ 40, _____ 80

DRUM NUMBER	pCi/g	1ST COUNT(cpm)	2ND COUNT(cpm)	3RD COUNT(cpm)	AVERAGE COUNT
10	2.4				
12	5.8				
13	22.4				

LINEAR REGRESSION FORMULA Y= A + BX WHERE Y= CPM AND X= pCi/g
A= R= 5.0 pCi/g =_____CPM
B= 7.2 pCi/g =_____CPM

CALIBR. DRUMS W/PVC & GEOPROBE STEEL PIPING: CABLE LENGTH _____ DIAMETER OF PIPE _____ SCH. OF PIPE _____ 40, _____ 80

DRUM NUMBER	pCi/g	1ST COUNT(cpm)	2ND COUNT(cpm)	3RD COUNT(cpm)	AVERAGE COUNT
CD-1	1.7				
CD-8	12.9				
CD-7	23.4				

LINEAR REGRESSION FORMULA Y= A + BX WHERE Y= CPM AND X= pCi/g
A= R= 5.0 pCi/g =_____CPM
B= 7.2 pCi/g =_____CPM